

## **ENERGY STAR Windows Rationale**

**May 8, 2002**

Changes to building codes around the country prompted the Department to consider whether the criteria for ENERGY STAR windows, doors and skylights needed to be updated to keep pace with state and local minimum energy efficiency requirements that had become more stringent in some parts of the country. Recent discussions have focused on the relationship between the International Energy Conservation Code (IECC) and the ENERGY STAR criteria. One central question needing to be addressed is what is the Department trying to accomplish with the ENERGY STAR windows program? Is the Department trying to support the IECC and state adoption of the code or, as with ENERGY STAR appliances, identifying the products that would be considered among the most energy efficient? In the former case, the Department would set the levels equal to the IECC criteria and update the criteria as the code is amended. If it is determined the purpose of the program is to lead the market, the Department would examine a range of impacts to determine the level that could be considered good practice.

### **Program Objectives**

***Should the ENERGY STAR levels be set at the same level as the International Energy Conservation Code (IECC), or set at a more aggressive level (where possible)?***

**Background:** In early 2001, the Department formally determined the 2000 edition of the IECC would “substantially improve the energy efficiency of low-rise residential buildings if adopted by all the states.” Each state is required to consider updating their codes to the 2000 IECC. If a state declines to update its code to the 2000 IECC, it must explain its rationale to the Department. To date, Arizona, California, Florida, Idaho, Iowa, Kentucky, Maryland, Massachusetts, Montana, New Hampshire, New York, North Carolina, Oregon, Pennsylvania, South Carolina, Texas, Utah, Washington, and the District of Columbia have adopted (or are about to adopt) the 2000 IECC, or have independent energy codes with window efficiency provisions that are equal to or more stringent than the 2000 IECC<sup>1</sup>. The prescriptive path of the IECC sets five distinct climate zones for replacement windows with different sets of requirements for each zone. [See Map 1 on p. 2 for IECC climate zones and specifications].

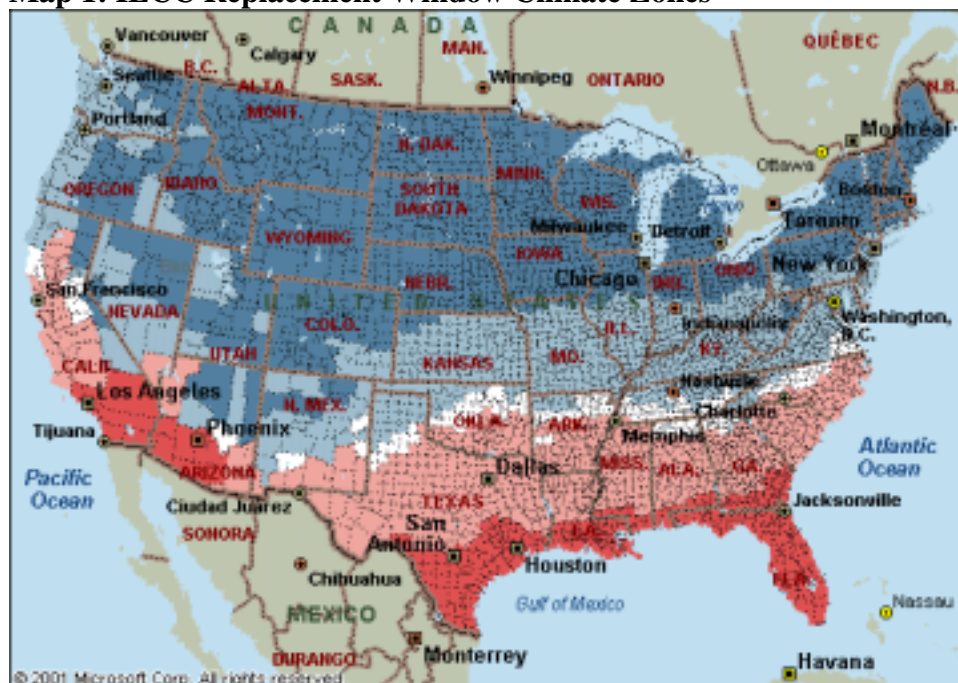
**DOE Decision:** The Department has determined the ENERGY STAR specification should be more stringent than the IECC wherever practical. States that to date have not adopted the IECC or comparable requirements have not traditionally established stringent energy codes, and are probably unlikely to do so. Setting the ENERGY STAR level at the same level as the IECC would be inconsistent with the specifications for other ENERGY STAR labeled products. In other product areas, in each case where there is a minimum code or standard for the product, the ENERGY STAR level has been set more aggressively than the code or standard. Setting the ENERGY STAR specification exactly at the IECC level would also require a five-zone proposal. [For analytical purposes in Table 1 on page 4 of this memo, DOE consolidated the 3,500 - 3,999 zone (which requires a 0.50 U-factor and any SHGC) with the 4,000 - 5,999 zone (which requires a 0.40 U-factor and any SHGC)]. Setting the ENERGY STAR criteria at a level equal to the 2000 IECC would also not meet California’s Title 24 building code. Perhaps most

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<sup>1</sup> Building Codes Assistance Project – March/April 2002 Newsletter <http://www.bcap-energy.org/030402.pdf>

importantly, setting the new ENERGY STAR specification at the same level as the 2000 IECC would result in national energy savings below even those achieved by the current ENERGY STAR specification. Adoption of the IECC levels would be a move backwards in terms of energy-efficiency criteria, particularly in the central region, which is so hotly discussed, and would probably be seen as a signal from the Department that it did not want to use the ENERGY STAR program to encourage the use of the most energy efficient products.

**Map 1: IECC Replacement Window Climate Zones**



*Prescriptive Requirements by Climate Zone*

<span style="color: red;">■</span>	0 – 1,999 HDD	0.40 SHGC	0.75 U-factor
<span style="color: red;">■</span>	2,000 – 3,499 HDD	0.40 SHGC	0.50 U-factor
<span style="color: white;">□</span>	3,500 – 3,999 HDD		0.50 U-factor
<span style="color: cyan;">■</span>	4,000 – 5,999 HDD		0.40 U-factor
<span style="color: grey;">■</span>	6,000 and above HDD		0.35 U-factor

Source: 2000 IECC Section 502.2.5: Prescriptive Path for Additions and Window Replacements, and Table 502.2.5: Prescriptive Envelope Criteria Additions to and Replacement Windows for Existing Type A-1 Residential Buildings. *See also* 2000 IECC Sections 502.1.5 & 502.2.4.15: Fenestration Solar Heat Gain Coefficient.

## Specification Options

*Since the decision has been made to set the ENERGY STAR criteria at a more stringent level than IECC where possible, what are the options?*

The Department looked at a range of proposals, including several by industry stakeholders, to determine a specification consistent with the goals of the ENERGY STAR program (energy savings, pollution prevention, superior performance, and broad market availability), and is consistent with the Department's broader mission of promoting energy security and reliability. As part of the decision making process, the Department analyzed proposals with three climate zones as the Current ENERGY STAR Program specification requires, and other proposals which ranged from one to four climate zones.

### *Notes on Proposals in Table 1:*

- **The Current ENERGY STAR Program** does not precisely fit the climate zones listed in Table 1. The Current ENERGY STAR Program was modeled using the original ENERGY STAR windows map, which has been in use since the beginning of the program.
- **Final Proposed ENERGY STAR** is a slightly modified version of the Original Proposed ENERGY STAR (OPE\*) from October 2001.
- **Original Proposed ENERGY STAR (OPE\*)** was developed through conversations with stakeholders in 2001 and proposed by DOE in October 2001.
- **Alternative Proposal 1** was developed by three glass manufacturers (TGM) and submitted to DOE in the fall of 2001.
- **Alternative Proposal 2** is suggested by LBNL and ADL based on criteria defined in both the Original Proposed ENERGY STAR (OPE\*) Program and the TGM proposal 1. The four zone requirements are mostly consistent with IECC's definition of climate zones but allowing for continuous zones.
- **Alternative Proposal 3** was developed by TGM and submitted to DOE in the fall of 2001. It is suggested as a second step after Proposal 1 change (i.e. to be implemented at some point in the future). (Note that Pella Corporation developed a proposal very similar to this except it's U-factor requirement for <3500 HDD was 0.4; this alternative proposal is not considered in this report. Heating energy savings are slightly increased but it eliminates the use of aluminum frames completely.)
- DOE considered **Alternative Proposal 4** in the summer/fall of 2001 as a Step 2 set of requirements for future adoption. Based on negative industry comments, it was decided by DOE not to further consider this proposal. It is presented in this report for the sake of completeness.
- **Alternative Proposal 5** is suggested by LBNL and ADL based on criteria defined in both the Proposed Program and the TGM proposal 1.
- **Alternative Proposal 6** is suggested by LBNL and ADL as a program to maximize energy savings, be mostly consistent with the IECC's definition of climate zones, and encourage all sectors of the window industry to offer improved products.
- **Alternative Proposal 7** was developed by Pilkington and submitted to the Department of Energy in February 2002.
- **Alternative Proposal 8** was proposed by Simonton Windows after 3/20/02 meeting.

**Table 1: Specification Options**

Reference/ Proposals	<2000 HDD	2000–3499 (includes CA Central Valley)	3500–5999	6000+
IECC	U≤0.75 SHGC≤0.4	U≤0.5 SHGC≤0.4	U<.4 (U≤0.5 3500 to 3999 HDD) SHGC- Any	U < .35 SHGC – Any
Current ENERGY STAR	U≤0.75 SHGC≤0.4		U≤0.4 SHGC≤0.55	U≤0.35 SHGC- Any
Final Proposed ENERGY STAR	U≤0.65 SHGC≤0.4	U≤0.4 SHGC≤0.4		U≤0.35 SHGC – Any
Original Proposed (OPE*)	U≤0.75 SHGC≤0.4	U≤0.4 SHGC≤0.4		U≤0.35 SHGC - Any
Proposal 1 (TGM Step 1)	U≤0.5 SHGC≤0.4		U≤0.4 SHGC≤0.55	U≤0.35 SHGC - Any
Proposal 2 (OPE* + TGM)	U≤0.75 SHGC≤0.4	U≤0.4 SHGC≤0.4	U≤0.4 SHGC≤0.55	U ≤0.35 SHGC – Any
Proposal 3 (TGM Step 2)	U≤0.5 SHGC≤0.4		U ≤0.35 SHGC – Any	
Proposal 4 (OPE* step 2)	U≤0.35 SHGC≤0.4			
Proposal 5 ( OPE* + TGM)	U≤0.75 SHGC≤0.4	U≤0.4 SHGC≤0.4	U≤0.35 SHGC - Any	
Proposal 6 (IECC +)	U≤0.6 SHGC≤0.4	U≤0.4 SHGC≤0.4	U≤0.35 SHGC–Any	U ≤ 0.32 SHGC – Any Or U≤0.35 if SHGC>0.5
Proposal 7 (Pilkington)	U≤0.75 SHGC≤0.4	U≤0.5 SHGC≤0.4	U≤0.4 SHGC–Any	U≤0.35 SHGC – Any
Proposal 8 (Simonton)	U≤0.6 SHGC≤0.4	U≤0.5 SHGC≤0.4	U≤0.4 SHGC–Any	U ≤ 0.35 SHGC – Any Or U≤0.38 if SHGC>0.5

**Table 2: Annual Energy Savings (TBtus)**

Scenario	Heating Savings	Cooling Savings	Total
IECC	(1.5)	7.8	6.3
Current ENERGY STAR	1.3	6.6	7.9
Final Proposed ENERGY STAR	1.0	9.3	10.3
Original Proposed ENERGY STAR	0.4	9.3	9.7
Proposal 1	2.4	7.8	10.2
Proposal 2	2.8	7.9	10.7
Proposal 3	3.6	7.8	11.5
Proposal 4	1.1	11.0	12.1
Proposal 5	4.3	7.9	12.2
Proposal 6	7.2	7.8	15.1
Proposal 7	0.8	7.7	8.6
Proposal 8	1.7	7.8	9.5

***Decisions and Rationale:*****Northern Zone (above 6,000 Heating Degree Days)**

*DOE Decision: ( $\leq 0.35$  U-factor, any SHGC): The criteria for windows in the Northern Zone remains the same as in the current ENERGY STAR criteria and the current IECC requirements. The Department believes that more stringent criteria in the Northern Zone would result in significant price increases (30 to 50 percent) that would not be economically justified. DOE believes setting a U-factor of 0.35, with no maximum solar heat gain, remains an appropriate way to encourage the sale of windows that reduce heating loads in the northern part of the country.*

Each of the proposals considered sets a U-factor maximum of less than or equal to 0.35, which is the level set by the IECC. The Simonton proposal adds the option of a U-factor of less than or equal to 0.38 if the SHGC of the window is greater than 0.50 to allow a greater range of product that takes advantage of passive solar gains. (Raising the U-value would also reduce energy savings). None of these proposals is set more aggressively than the IECC because reducing the U-factor below 0.35 in this region would require triple glazing (at a price premium of 30 – 50%, and without a guaranteed payback for the consumer).

If the criteria were strengthened to only allow triple-glazed products to qualify for the ENERGY STAR label, the market share of efficient products might actually decline in the Northern Zone, and in other zones. This would happen if manufacturers of efficient double-glazed Low-E

products stopped marketing them as ENERGY STAR qualified. Several large window companies stated in the March 20<sup>th</sup> public meeting they are only using the ENERGY STAR marketing message on products qualifying in all regions of the country. If triple-glazing is required in the Northern Zone to meet ENERGY STAR requirements, there would not be products sold in all parts of the country that would qualify, since triple-glazed products are not generally sold in the south. This would mean a large segment of double glazed Low-E wood and vinyl products (which predominate in the market) would no longer be marketed as ENERGY STAR qualified, and consumers would not be exposed to efficiency marketing messages in nearly as many areas as they would have otherwise. Triple-glazed products currently have about a one percent market share nationally, and are thus not a significant part of the market, even in the Northern Zone<sup>2</sup>.

Low-E glass (all types) accounts for roughly 40 – 70% of new window sales, across the region (the highest percentages are in the Pacific Northwest and New England)<sup>3</sup>. Under any of the proposed specifications, all glass manufacturers will have products that could qualify for ENERGY STAR.

### **Central Zone (3,500 – 6,000 Heating Degree Days)**

*DOE Decision: ( $\leq 0.40$  U-factor,  $\leq 0.40$  SHGC): The Central Zone contains the most significant change from the current ENERGY STAR criteria. The Central Zone has been redefined to approximately represent those parts of the country between 2,000 and 6,000 Heating Degree Days (HDD). This climate zone takes into consideration the requirements of state codes (including Title 24 in California) and the IECC (adopted as state code in several southern states). While alternative criteria would save more energy, the Department was swayed by the fact that more cooling energy would be saved in this region due to the increased stringency of the SHGC requirement. Furthermore, this will help alleviate summer peak load cooling loads, which is a major consideration for many ENERGY STAR utility partner programs.*

The two key questions in this region were: whether to set a maximum solar heat gain coefficient; or whether to extend the requirements of the Northern Zone into this region. The IECC does not require a SHGC in the 3,500 – 5,999 HDD portion of this zone. Of the proposals under consideration, only the Final Proposed ENERGY STAR and Original Proposed ENERGY STAR set a maximum SHGC of 0.40 within this subsection of the region. If a SHGC maximum of 0.40 is set, products using soft-coat (sputtered) Low-E technology will be able to meet the ENERGY STAR specifications, while hard-coat (pyrolitic) products could meet the specification only with triple-glazing which is presumed not to be cost-effective. Low-E market share in the total region including both hard-coat and soft-coat technologies ranges from roughly 10 – 50%<sup>4</sup>.

Manufacturers of hard-coat products, which wouldn't be able to achieve these solar heat gain reductions, argue the annual energy savings are greater. (DOE's analysis does show proposals that don't limit SHGC have a slightly greater overall energy savings – see Table 2 on p. 5 – but the differences are marginal at best, and trade heavily between heating and cooling savings).

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<sup>2</sup> Source: Ducker Research Corporation, "Study of the U.S. and Canadian Market for Windows and Doors", April 2000.

<sup>3</sup> Source: Ducker Research Corporation, "Study to Quantify and Profile the U.S. Market for Residential and Light Commercial Windows and the Technology for High-Performance Windows", December 1997.

<sup>4</sup> Ibid.

Manufacturers of soft-coat Low-E products argue annual energy savings are roughly equivalent, which according to the analysis is true, and that providing cooling savings in the summer offers electricity reliability and pollution benefits while offering customers superior comfort.

Proposal 5 would extend the specifications of the Northern Zone (requiring less than or equal to a 0.35 U factor and any SHGC) to approximately the 3,500 HDD line. This proposal would eliminate many popular metal-clad wood windows, which have U-factors between 0.35 and 0.40 from ENERGY STAR qualification, and several companies have expressed opposition to Proposal 5 on this basis. Currently, metal clad wood windows comprise almost 40% of all sales of wood windows nationally, and 15.7% of the overall windows market (by comparison, non-clad wood windows represent only 4.5% of national sales).<sup>5</sup>

Over the last several years, hard-coat Low-E products have been losing market share to soft-coat Low-E products. Hard coat Low-E products now account for 20% of the Low-E market, down from a high of 40%.<sup>6</sup> One of the reasons for this trend is that many national window manufacturers and national big box retailers have been switching to products that can be marketed as qualifying for ENERGY STAR in all regions of the country. This can be achieved more easily with a soft-coat Low-E product. As energy remains a strong issue in the news and energy prices remain high in many parts of the country, energy efficiency has become one of the major selling points for window manufacturers and retailers. Summertime comfort is a key benefit of ENERGY STAR qualified windows and big box retail partners have incorporated both Low-E and SHGC into their marketing messages. Manufacturers of hard-coat products have not been as active in marketing with ENERGY STAR.

The IECC sets the criteria for U-factor in the southern part of the Central Zone (areas between 2,000 and 3,500 heating degree days) at less than or equal to 0.50 and the SHGC at less than or equal to 0.40. The Simonton proposal has the same U-factor requirement as the IECC, and most of the other proposals all set the U-factor at less than or equal to 0.40. All of the proposals have the same SHGC maximum of 0.40. Low-E market share in the region including both hard-coat and soft-coat technologies is about 20%.<sup>7</sup> Aluminum products, which have historically held major market share in this region have been precluded in parts of the following states in this zone that have adopted the IECC: Arizona, North Carolina, South Carolina and Texas. California has a more stringent requirement of a 0.40 U-factor and a 0.40 SHGC in parts of the state between 2,000 and 3,500 heating degree-days. Only thermally-broken aluminum products would be able to qualify for ENERGY STAR at either the 0.50 or the 0.40 U-factor maximums. According to the NFRC database, about 670 thermally-broken aluminum products are available at the 0.50 level and about 260 are available at the 0.40 level.

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<sup>5</sup> Source: Ducker Research Corporation, "Study of the U.S. and Canadian Market for Windows and Doors", April 2000.

<sup>6</sup> Source: Ducker Research Corporation, "Study of the U.S. and Canadian Market for Windows and Doors", April 2000.

<sup>7</sup> Ducker Research Corporation, "Study to Quantify and Profile the U.S. Market for Residential and Light Commercial Windows and the Technology for High-Performance Windows", December 1997.

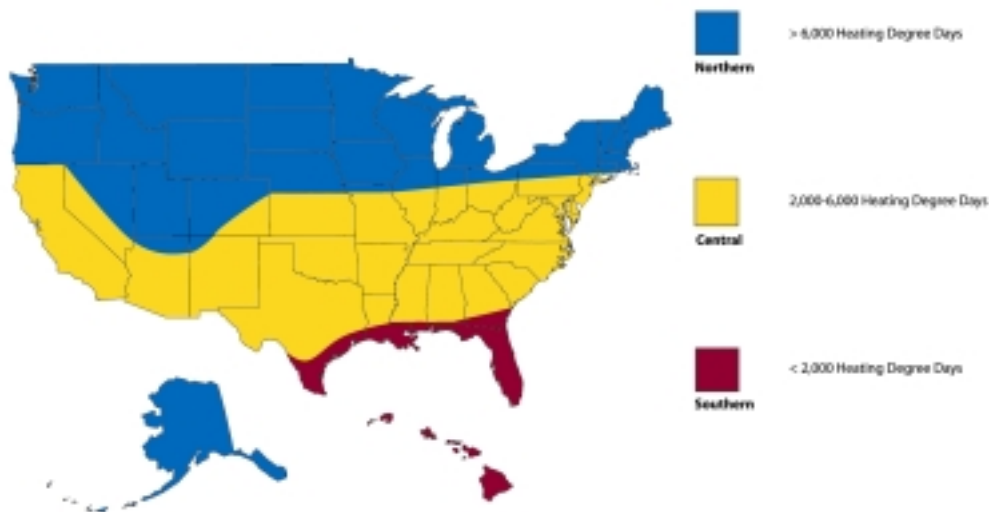
### **Southern Zone (below 2,000 Heating Degree Days)**

*DOE Decision: ( $\leq 0.65$  U-factor,  $\leq 0.40$  SHGC): The major new features of this part of the criteria are the new definition of the Southern Zone below 2,000 HDD and the reduction of the U-factor requirement. One technology the Department gave particular attention was aluminum products. DOE believes aluminum product manufacturers will be able to supply products meeting this requirement. The emphasis on Southern Zone criteria is on reducing cooling load demands for the extreme south.*

The IECC criteria for the Southern Zone are for a U-factor less than or equal to 0.75 and a SHGC less than or equal to 0.40. The Final DOE proposal sets the U-factor at less than or equal to 0.65, and the Simonton Proposal sets the U-factor at less than or equal to 0.60. Low-E market share in the region including both pyrolitic and soft-coat technologies is between 15 and 20%<sup>8</sup>.

Aluminum windows with clear glass predominate in this zone, and most of the energy savings potential in this region is in cooling energy savings resulting from a low solar gain product. Each of the proposals has the same solar heat gain requirements, so the only difference among them is in U-factor that will save heating energy. Dropping the U-factor from 0.75 to 0.65 will save heating energy by requiring manufacturers to move to thermally-broken aluminum products, especially below a U-factor of 0.65. Dropping below a U-factor of 0.65 will eliminate virtually all operable non-thermally-broken windows from ENERGY STAR qualification. There are some non-thermally-broken fixed windows available with U-factors of below 0.65. Even though heating use is low in these regions, dropping to 0.65 provides energy savings over the IECC and other proposals.

### **Map 2: Adjusted Climate Zone Map for Potential ENERGY STAR Specifications**



<sup>8</sup> Ibid.